



Canyonlands

The official newspaper
of Canyonlands National Park

Parks as Labs

NATIONAL PARKS PROTECT A TREMENDOUS VARIETY OF NATURAL AND cultural wonders. The cliff dwellings of Mesa Verde, the thermal features of Yellowstone, the canyons of Canyonlands – these and other parks present opportunities for visitors to explore features that often don't exist anywhere else in the world.

National Parks also present unique opportunities for scientific research. Of course many scientists study the various wonders for which parks were established, but that's not all. Many parks prohibit activities like hunting, grazing, mining and off-road vehicle use that occur elsewhere on public and private lands. These regulations create a "control" area to which scientists can compare the affects of these activities elsewhere. This is especially important in the American west where parks often serve as the best model for what an undisturbed landscape should look like. For example, in order to assess soil fertility around an old copper mine, one would need benchmark values from a similar environment where no mining had occurred. National Parks can make establishing such benchmarks easier.

Over the years, Canyonlands has served as an outdoor laboratory for a variety of scientists. Given the landscape, it is no surprise that much of this research focuses on geology and soils. From the Island in the Sky's Upheaval Dome to the Grabens area of the Needles, Canyonlands possesses many uncommon landforms. The fact that over 200 million years of geologic history are visible in the park draws scientists from all over the world.

Soil science has been a dominant research topic at Canyonlands for years. Since the 1970s, researchers have been uncovering the role biological soil crusts play in the high desert ecosystem. Since topsoil erosion and fertility have become issues of global importance, understanding the mechanisms which maintain healthy soils in deserts might benefit areas all over the world.

Much of the soil research has focused on the impacts of grazing and exotic grasses, especially the invasive cheatgrass (*Bromus tectorum*). This European import has overcome rangeland throughout the western United States. Animals rarely eat it and it appears that native grasses cannot compete with it. Scientists at Canyonlands are studying how changes in soil chemistry affect the ability of cheatgrass to transform a landscape.

In addition to such far-ranging benefits, research in Canyonlands also aids park managers. Much like a physician monitors a patient's heartbeat and blood pressure for diagnostic purposes, National Park Service officials need accurate information about the resources in their care. Specifically, they need to know how and why natural systems change over time, and what amount of change is normal, in order to make sound management decisions.

Scientists have been implementing an integrated inventory and monitoring program. The first phase of the program is to verify



Monitoring bighorn sheep along the Colorado River (top). Collecting soil samples in the Needles District (middle). The long, parallel canyons of the grabens (lower left), and a grassland inundated by cheatgrass (lower right).

records of what plants and animals exist in Canyonlands. To accomplish this, teams of scientists are conducting inventories of plants, mammals, reptiles, amphibians and birds.

The second phase of the program is the development of vital signs monitoring. Vital signs are measurable, early warning signals that indicate changes which could affect the long-term health of natural systems. Canyonlands, along with other parks, is planning a program to monitor biological and physical resources like air quality, water quality, exotic species, soils, and threatened and endangered species

Most of the articles in this newspaper address some aspect of research in Canyonlands. For a complete list of ongoing projects, as well as reports from the last few years, please visit our website at www.nps.gov/cany and click on "Nature and Science."



Welcome!

"That in order to preserve an area in the State of Utah possessing superlative scenic, scientific, and archeologic features for the inspiration, benefit and use of the public, there is hereby established the Canyonlands National Park..."

This passage from the public law passed by Congress in 1964 set aside a remarkable landscape containing much of the Colorado and Green River basins around their confluence. As Americans, we hold this to be a special place that preserves a part of this nation's natural and cultural heritage.

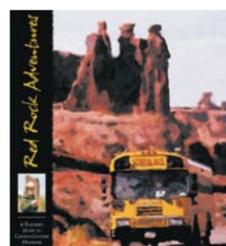
Canyonlands offers a full spectrum of discovery and experience. The Island in the Sky provides a raven's view of endless canyons and mesas. The Needles, whether accessed by vehicle or on foot, is a visual feast that constantly teases you into wanting to see what's around the next sandstone fin or knob. Venturing into the remote canyons of the Maze District allows visitors to lose and find themselves at the same time. Finally, floating the calm waters of the Green or Colorado Rivers is nothing short of soothing therapy for the soul, while the rapids of Cataract Canyon below the confluence rouse your spirit.

Canyonlands is a place to make and share memories that can sustain you for a long time to come. I hope you rest, relax, recreate and, most importantly, remember your time here. As you leave the park behind, please take a piece of it home in your heart. On behalf of the dedicated National Park Service staff and our many volunteers, I truly hope that you safely enjoy your visit.

Tony Schetzle
Superintendent



Thanks to you, improvements are being made throughout the park. See back page for details.



TEACHERS!

Red Rock Adventures: A Teacher's Guide to Canyon Country Outdoor Education contains over 100 science activities for grades one through six. Topics are taken directly from the Utah State Science Core Curriculum guidelines and are correlated to the National Science Standards. To download lesson plans and learn more about the program, visit www.nps.gov/cany and click on "For Teachers."



IT'S ALIVE!

Watch your step as you're exploring the park. See the back page for more information on living soil crusts.



National Park Service
U.S. Department of the Interior

Canyonlands Park News

Published By

Canyonlands Natural History Association (CNHA), a nonprofit organization that assists the National Park Service in its educational, interpretive and scientific programs. CNHA's goals include enhancing every visitor's understanding and appreciation of public lands by providing a selection of quality, educational materials for sale at the park visitor centers. For more information, contact CNHA at (435)259-6003, or visit their website at www.cnha.org.

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Cover Photo

Grand View Point, Island in the Sky

The National Park Service cares for the special places saved by the American people so that all may experience our heritage.

Bat Inventory Completed

THE INVENTORY AND MONITORING PROGRAM at Canyonlands recently concluded a two-year bat inventory which yielded a wealth of information about this little-known and often underappreciated group of animals.

Dr. Mike Bogan of the U.S. Geological Survey in Albuquerque, together with his colleague, Dr. Tony Mollhagen, confirmed the presence of 16 native bat species in the park. Previous studies confirmed only eight species. As a comparison, only 18 bat species have been documented in the state of Utah. The 'bat team' worked at 34 different sites throughout the park and used two different methods to document bats: mist nets and acoustic surveys.

The team deployed mist nets near bodies of water and other flyways to capture bats coming to drink or feed on insects, their primary food source. The nets ranged from nine to 60 feet long. One to five nets were set up each evening, depending on the area and shape of the body of water at the sampling site. Nets were erected shortly before sunset and maintained until early morning when bats are most active. The team never left mist nets untended in order to prevent captured bats from being injured. Once a bat was captured, team members recorded the species, sex, reproductive condition, time of capture and descriptive comments about individual animals.

Acoustic surveys involve the use of a bat detector which records bat echolocation calls. While bats can see as well as humans, they have a sophisticated method of using sound—echolocation—which enables them to navigate and find food in the dark. Bats produce echolocation by emitting high frequency sound pulses through their mouth or nose and listening to the echo. With this echo, the bat can determine the size, shape and even texture of objects in its environment. Most bat echolocation occurs beyond the range of human hearing. While humans



Two of our resident bats: Above left, Allen's Big-eared Bat (*Idionycteris phyllotis*), the last bat species to be discovered in Utah. Above right, Western Pipistrelle (*Pipistrellus hesperus*), the most abundant bat in the area.



can hear up to 20 kHz (depending on age), bat calls range from 9 kHz to 200 kHz.

Scientists have devised methods for eavesdropping on bats with the use of bat detectors. Bat detectors contain ultrasonic microphones that can detect bat echolocation and output the incoming call within the range of human hearing. These electronic signals are recorded and processed to assist in the identification of bat species. For the Canyonlands inventory, bat detectors were positioned at nine sampling sites across the park for one to two nights, either on the ground or attached to a tripod. The detection systems were programmed to record from 30 minutes before sunset to 30 minutes before sunrise.

Over the course of the study, the bat team captured and identified 1,717 bats with mist nets. The team released all bats unharmed at their capture site. The maximum catch on a single evening was 134 bats representing 10 species. The average catch per night was 26 bats (four species). The team identified 3,751 recordings with the use of bat detectors, with a total of 11 species. The maximum number of identifiable individual calls recorded during one night was 825, with a species count of nine. The average recordings per night were 250 calls (six species).

The study showed that several sites in Canyonlands provide exceptional habitat for bats. Chief among them is Salt Creek Canyon between the junction with Horse Canyon and Peekaboo. A whopping 62% of the total bats captured came from the sampling sites in this area. These sites also yielded high species diversity, suggesting that a variety of species can meet their resource needs along this riparian corridor.

No federally listed Threatened or Endangered bats were discovered in Canyonlands. However, the state of Utah lists five of the 16 bat species found as "wildlife species of concern" — species for which there is credible scientific evidence of threats to a population's continued viability. Although they are long-lived (5 to 20 years), bats are vulnerable because they have low reproductive rates (one "pup" per female per year) and often roost in large groups where disturbances can affect a lot of animals at once.

Bats have been maligned in folklore and literature throughout our history. Yet these diverse flying mammals control insect populations, pollinate plants, disperse seeds, and pose little threat to people who do not handle them. Look for bats emerging from their day roosts in Canyonlands at dusk, especially in the spring and summer months.



Interpretive program at Grand View Point



Mountain biking on the White Rim Road



Sunrise at Mesa Arch

Exploring Island in the Sky

Basics

- Visitor center is open 8:00 a.m. to 6:00 p.m. from April to late October, and 9:00 a.m. to 4:30 p.m. the rest of the year. Features exhibits, book and map sales, audio-visual programs, backcountry permits, general information, and park rangers on duty.
- There are no free water sources at the Island. Water is sold in the visitor center at the front desk and at a vending machine outside.
- Orientation movie: *Wilderness of Rock* is shown on request at the visitor center (15 minutes).
- Vault toilets are located at the visitor center, Grand View Point, Green River Overlook, Upheaval Dome, White Rim Overlook and Willow Flat Campground. The visitor center toilets are wheelchair accessible.
- Campground at Willow Flat has 12 sites available on a first-come, first-served basis. No water or hookups provided. Nightly fee is \$10 per site.

Scenic drive

A 34-mile (round-trip) scenic drive allows visitors to tour the entire mesa top. The *Road Guide to Canyonlands - Island in the Sky District* offers an insightful narrative for the trip and can be purchased at the visitor center. A self-guided driving tour CD is also available for sale or loan. Wheelchair accessible overlooks include Grand View Point, Green River Overlook and Buck Canyon Overlook. There are picnic areas at White Rim Overlook and Upheaval Dome.

Interpretive activities

- Interpretive brochures are available for Mesa Arch and Upheaval Dome.
- Ranger programs: Geology talks (30 minutes) are presented daily at 10:30 and 11:30 a.m. at Grand View Point (April to late October). Afternoon talks and activities are presented daily (April to September). Check at the visitor center or campground for times and topics.

For kids

Free Junior Ranger booklets are available at the visitor center. Kids age 6 to 12 can earn a Junior Ranger badge by completing five or more activities in the book. For hiking, kids enjoy peeking through Mesa Arch and climbing the back of the whale at Whale Rock. Use caution as there are unfenced overlooks on both of these trails.

What to do with your day

First, stop at the visitor center for current information on trails, roads, interpretive programs, weather, or to watch the park orientation movie.

If you have 2 hours:

Drive to Grand View Point or Green River Overlook. Hike to Mesa Arch.

If you have 4 hours:

Drive to Grand View Point, Green River Overlook and Upheaval Dome. Hike the Grand View Point, Mesa Arch, and Upheaval Dome Overlook trails.

If you have 8 hours:

Visit every overlook. Hike several mesa top trails or one of the more strenuous trails descending to the White Rim. Enjoy lunch on the trail or at White Rim Overlook or Upheaval Dome picnic areas.

If you are interested in geology:

View the exhibits at the visitor center and pick up a geology handout. Visit Grand View Point to see the rock layers. Visit Upheaval Dome and hike to the first overlook. There you can learn two theories about how the crater might have been formed.

If you are interested in natural history:

View the visitor center exhibits and pick up a free natural history handout. As you pass through Gray's Pasture, watch for mule deer or bighorn sheep. Walk the Mesa Arch or Neck Spring trails and learn about native plants.

If you are interested in human history:

View the visitor center exhibits and pick up a free handout. Hike the Aztec Butte Trail to see ancestral Puebloan ruins. Hike the Neck Spring Trail to view remnants of the ranching era. Old fences and corrals are visible along the scenic drive and Murphy Point Trail. Also, old mining roads are visible from most overlooks.

If you are interested in watching sunrise/sunset:

Find out sunrise and sunset times at the visitor center. Visit Mesa Arch at dawn. Visit Green River Overlook or Grand View Point at dusk for incomparable views of sunset over the canyons. Hike to the top of Aztec Butte for a spectacular view of the Island in the Sky and surrounding countryside.

Monitoring a Moving Target: Water

CANYONLANDS NATIONAL PARK MONITORS the water quality of nine springs, seeps and canyon pools, and five sites on the Green and Colorado rivers. After examining the results of monitoring from 1994 through 2004, we can now better answer the most common question that visitors ask: “How is the water?”

But first, another question: “Why monitor?” Water is scarce in the high desert and critical to the area’s ecology. The Colorado and Green rivers are constant water sources for wildlife. But during drier times, water in smaller streams, potholes, seeps, and springs becomes critical to wildlife not able to travel to the rivers. Besides the existence of these sources, which we monitor by measuring flow at the sites, their water quality is important. Small actions by park visitors, including taking a dip in a pool while covered in sunscreen, can pollute a water source. Broader threats include climate change, groundwater pumping from nearby wells, and water flowing into the park containing sewage system discharges as well as runoff from farming, roads, energy development, mining or new housing. One-time events, human-induced or natural, can cause short-term impacts. Other threats can cause slower, long-term decreases in water quality and quantity. Though our monitoring can detect one-time events, it is also designed to detect the slower changes.

Scientists sample river sites spring through fall and other sites monthly every third year. They measure temperature, dissolved oxygen, pH, and specific conductivity (related to salinity), collect water samples in sterile containers, and measure flow. Three times a year they survey aquatic life in an effort to understand their relationship to water quality. They test one sample locally for fecal coliform bacteria, and mail the other samples to a state laboratory that tests them for up to 32 chemical, nutrient, mineral and metal components.

The question “How is the water;” requires an understanding that water quality is a moving target. Water quality parameters interact with each other and with the environment, and vary seasonally. Certain metal levels vary with water hardness. Dissolved oxygen varies with time of day, amount of aquatic vegetation, agitation, temperature, and pollutants.



Surveying invertebrates in the Maze District.

Water quality standards, set by the state, the U.S. Environmental Protection Agency, and to a lesser extent the National Park Service, reflect this complexity, and also vary depending on use. One pool may have different standards for drinking water, recreation, agriculture, and aquatic life. Aquatic life standards have both chronic limits - a level that is only a problem if sustained - and acute limits.

Despite these complexities, by examining the results from the last eleven years we can see some patterns. We looked for any values that did not fall within standard ranges, and then took a closer look at recurrent conditions, meaning that there were three or more exceedences of a particular standard at a particular site. The number three is arbitrary, but it is useful for focusing on potential problems.

Generally, water quality in Canyonlands National Park is good. In eleven years of monitoring, many parameters were always within standards or at least never consistently broke standards. These include pH, alkalinity, arsenic, barium, cadmium, chloride, chromium, iron, lead, mercury, nitrogen, silver and zinc. However, the river sites have a few parameters that were frequently or constantly higher than standards, and all of the spring and pool sites have one or a few parameters with recurrent high readings.

Phosphorus is often high at all of the sites, especially on the rivers. Phosphorus can come from fertilizers, detergents, human, domestic



Tadpole shrimp inhabit pools throughout the park.

animal, and wildlife wastes, wind-deposited dust, soil leaching, and other geologic sources. High phosphorus levels at the pools and springs probably result from the natural sources among these. Two Needles District sites, Cave Spring and near Peekaboo Spring in Salt Creek, had the highest phosphorus levels among the pools and springs. Both sites are frequented by visitors and may be occasionally contaminated by human waste. The higher phosphorus levels in river waters result from upstream sources, probably dominated by agricultural runoff and occasional overflow from sewage treatment plants.

Dissolved solids, suspended solids and turbidity were consistently high at all river sites and were high at least three times at roughly half of the smaller water sites. The high readings at spring and pool sites probably correspond to sampling after big rain events, except at Peekaboo Spring, which is frequently agitated by vehicles on a four-wheel-drive road that crosses the site. The rivers collect runoff for hundreds of miles upstream, with natural sediment input increased by grazing, agriculture, roads, off-road vehicle use, fires, drought, and anything else that removes natural vegetation from the land.

Aluminum and selenium leach from some rock layers. Both were often above the chronic aquatic life standard at several sites, but in most cases, they probably reflect short-term and not chronic conditions. These marginally high levels of aluminum were measured at

three sites in the Maze District and from the river sites, with high levels most common on the Green River. Selenium was marginally high 12 to 25 percent of the time on the Colorado River and most of the time at one Needles spring site in Little Spring Canyon.

Sulfate levels were above drinking water standards almost half the time on the Colorado River, and less frequently on the Green River and in Horseshoe Canyon. Manganese was never high on the rivers, but exceeded a drinking water standard at most spring and pool sites at least three times. Both leach from rock layers, though sulfate can also have human-induced sources.

The Peekaboo Spring site has the only water temperatures above the standards for aquatic life, probably because the road eliminates plants and their shade, and the shallow water is more easily warmed.

Fecal coliform bacteria levels are generally non-existent or low at springs and pools, though the standard for swimming was surpassed once or twice at most sites, and four times at the Peekaboo Spring site. Most high counts correspond to times when runoff increased following rains, or in the case of Peekaboo Spring, after vehicles drove through. Runoff washes in fecal matter from wildlife, upstream cattle, or humans, and bacteria cling to sediment, which usually settles out within a couple days. Coliform can’t be tested at the river sites because of a quick processing requirement.

The monitoring program cannot test for all pollutants, and does not test for many human pathogens, including giardia and some other human pathogens. To protect yourself, always carry your drinking water or a suitable treatment system.

To preserve water quality, bury your waste at least 200 feet from any water source, and don’t swim in pools, especially small ones with no flow through them. If you need to cool off, collect a small amount of water from a pool, move away, and pour the water over your head and clothes. And as you do, think about the role of those precious drops in this arid landscape.

Exploring The Needles

Basics

- Visitor center is open 8:00 a.m. to 5:00 p.m. from April to late October, and 9:00 a.m. to 4:30 p.m. the rest of the year. Features exhibits, book and map sales, audio-visual programs, backcountry permits, general information, picnic area, and park rangers on duty.
- Water is available year-round at the visitor center and at the Squaw Flat Campground.
- Orientation movie: *Wilderness of Rock* is shown on request at the visitor center (15 minutes).
- Restrooms are available at the visitor center and Squaw Flat Campground (wheelchair accessible). There are also vault toilets at Elephant Hill.
- Squaw Flat Campground has 26 sites available first-come, first-served. No hookups. Nightly fee is \$15 per site.

Scenic drive

The scenic drive continues 7 miles past the visitor center, ending at Big Spring Canyon Overlook. Along the way are several pullouts for short hiking trails, viewpoints and a picnic area. Graded gravel roads lead to Cave Spring, where there is an interpretive trail, and to the Elephant Hill trailhead, where there is a second picnic area. The Elephant Hill access road provides excellent views of the Needles from a car (about one mile from the pavement).

Interpretive activities

- Interpretive trails (with printed guides) include Cave Spring, Pothole Point, Roadside Ruin and Slickrock.
- Campfire programs are presented five nights a week at Squaw Flat Campground (April to October). Check at the visitor center or campground for topics and times.

For kids

Free Junior Ranger booklets are available at the visitor center. Kids age 6 to 12 can earn a Junior Ranger badge by completing five or more activities. The Cave Spring Trail, featuring a cowboy camp and prehistoric pictographs, is always a hit with kids. Pothole Point is another popular hike, especially if the potholes are full of water. Before you set out, rent a kids’ discovery pack from the visitor center. Packs include a naturalist guide, binoculars, hand lens and more (small fee and deposit required).

What to do with your day

First, stop at the visitor center for current information on trails, roads, interpretive programs, weather, or to watch the park orientation movie.

If you have 2 hours:

Drive to Big Spring Canyon Overlook and hike the Pothole Point trail along the way. Drive to a view of the Needles on the Elephant Hill access road.

If you have 4 hours:

Explore the scenic drive and graded dirt roads. Hike the Cave Spring, Pothole Point and Roadside Ruin trails or the longer Slickrock trail.

If you have 8 hours:

After exploring the scenic drive, hike to Chesler Park or around the Big Spring-Squaw Canyon loop. Enjoy lunch on the trail.

If you are interested in geology:

View the exhibits at the visitor center and pick up a free geology handout. Every Needles trail provides unique views of rock formations, and marine fossils are visible in the canyon below Big Spring Canyon Overlook (follow the Confluence Trail).

If you are interested in natural history:

View the visitor center exhibits and pick up a free natural history handout. Bighorn sheep are seen most frequently from overlooks along the Slickrock Trail. Squaw, Lost and Salt Creek canyons are great for early-morning birding.

If you are interested in human history:

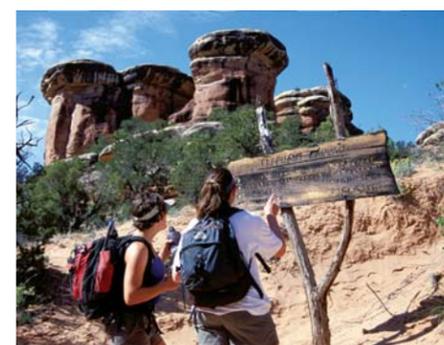
View the visitor center exhibits and pick up the free human history handout. Hike the Roadside Ruin and Cave Spring trails. If time permits, visit the Peekaboo rock art panel in Salt Creek Canyon.

If you are interested in watching sunrise/sunset:

Find out sunrise and sunset times at the visitor center. Sunrise is spectacular from the campground area, especially along the short trail over the butte between Loops A and B. Visit Pothole Point or Wooden Shoe Arch Overlook as the glow of sunset washes over the Needles.



Pothole Point



On the trail to Chesler Park



Rock spires in Chesler Park



A raft plunges through a rapid on its way through Cataract Canyon.

Backcountry Areas

Much of the land in Canyonlands remains undeveloped, a fact evident at any of the overlooks along the Island in the Sky scenic drive. The park's primitive character has made it a popular destination for backcountry travel. In every district, rugged roads, trails and rivers provide paths into remote corners of the park.

The White Rim Road, a 100-mile loop below the Island in the Sky mesa, is a favorite of mountain bikers and four-wheel drivers. The Needles provides ideal itineraries for backpackers in search of solitude. The Maze offers opportunities for lengthy exploration by foot and vehicle. Due to its remoteness and the difficulty of roads and trails, travel to the Maze requires more time, as well as a greater degree of self-sufficiency.

Yet another way to see the park is on the rivers. Boaters can float down the flatwater sections of the Colorado and Green rivers to the Confluence, or continue downstream to face 14 miles of rapids as the river tumbles through Cataract Canyon.

Rock art enthusiasts should be sure to visit Horseshoe Canyon, a detached unit of Canyonlands northwest of the Maze. A moderately strenuous hike leads to a series of pictograph panels created by hunter-gatherers over 2,000 years ago.

If you're interested in planning a trip to any of these areas, request a copy of the *Canyonlands Trip Planner*, or visit our website at www.nps.gov/cany.

Thanks to You

CANYONLANDS NATIONAL PARK WILL ENCHANT YOU WITH ITS MYSTERY AND BEAUTY. MILES of roads and trails offer access to a colorful geologic wonderland in the heart of the high desert of southeastern Utah – a masterpiece of nature's work. From sagebrush and claret cup to bighorn sheep and lizards, hundreds of species of plants and animals weave color and texture into Canyonlands' diverse landscape.

With all this majesty, hundreds of thousands of hikers, campers, boaters and other outdoor enthusiasts are drawn to Canyonlands each year. The park's popularity creates a challenge – to assist and protect its visitors, while preserving the natural and cultural treasures that brought them here in the first place. With your park fees and continued support, we can meet this challenge together.

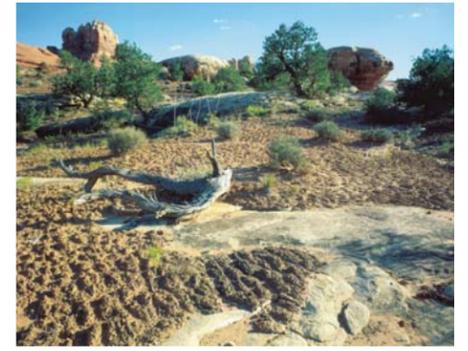
In 1996, Congress authorized the Recreational Fee Demonstration Program in order to reverse the deteriorating scope and quality of federal facilities and address natural and cultural resource issues. In 2004, Congress passed the Federal Lands Recreation Enhancement Act that continues the fee programs for an additional 10 years. Prior to these programs, user fees were returned to the general fund of the federal government and parks were reimbursed only for their collection costs. Now, Canyonlands keeps 80% of camping and entrance fees. During the past nine years, over 5 million dollars in retained fee revenue has been put to work at Canyonlands.

The park's trail crew continues to perform routine maintenance on over 120 miles of trails. All of the paved roads at Canyonlands have received preventative maintenance that extends their life and makes travel safer. Campsites have been rehabilitated both in the frontcountry and along the White Rim Road.

National Park Service employees and volunteers work hard to protect the resources of Canyonlands. Now you're a partner in this important work. Thanks to you, park facilities and programs are improving, and visitors can continue to experience this national treasure for generations to come.



A member of the Conservation Corps constructing a shade structure at the Island in the Sky Visitor Center.



WATCH YOUR STEP! Cryptobiotic soil crust is a living groundcover that forms the foundation of high desert plant life in Canyonlands and the surrounding area. This knobby, black crust is dominated by cyanobacteria, but also includes lichens, mosses, green algae, microfungi and bacteria.

Protect Your Park

- Avoid trampling cryptobiotic soil crusts. Always walk on trails, slickrock or in sandy wash bottoms.
- Pets are not allowed on hiking trails or four-wheel-drive roads, even in a vehicle. Pets may be walked along paved roads and in the campground, but must be leashed at all times.
- Protect water sources. Do not swim or bathe in potholes or intermittent streams.
- Preserve your heritage. Do not enter, alter or deface archeological sites. Leave artifacts undisturbed.
- It is illegal to remove natural or cultural features including plants, rocks, artifacts, driftwood or antlers.
- Vehicles and bicycles must travel on designated roads.
- ATVs are not permitted.

Protect Yourself

- Drink at least one gallon of water per day if you're active in the desert.
- Always carry a map, adequate clothing and flashlight in the backcountry.
- Remain in one place if you become lost or separated from a group.
- Always let someone know where you are going and when you expect to return.
- Never cross a canyon that is flooding.
- During lightning storms, avoid lone trees and high ridges. Sit in a vehicle if possible.
- Be careful near cliff edges, especially when rock surfaces are wet or icy.

How Deep is the River?

BY ROBERT H. WEBB, PETER G. GRIFFITHS AND CHRISTOPHER S. MAGIRL

ASK ANY RANGER OR RIVER GUIDE HOW DEEP the river is and they'll probably roll their eyes. Aside from being a common question, it's a very difficult one to answer accurately. The reason? The Colorado and Green rivers have serpentine channels that change constantly as the current and the sediment it carries act upon each other. Along both rivers, sand bars move continually. Add runoff from storms and spring snowmelt to the mix, and one could argue that few places in the river ever have the same depth for very long.

But what's below all this shifting sediment? The Colorado and Green rivers carry and traverse millions of tons of sand, mud and rocks, but at some point their channels must encounter bedrock. At what depth? Scientists studying this question in Cataract Canyon have found some unexpected answers.

Cataract Canyon contains roughly 14 miles of closely spaced, large rapids. These noise makers stand in stark contrast to the calmer conditions upstream on both the Green and Colorado rivers. Glen Canyon, below Cataract, was also known as a leisurely stretch of water before it filled with the waters of Lake Powell. So Cataract Canyon interrupts an otherwise continuous calm with large and treacherous hydraulics.

The rapids of Cataract Canyon are created by very large boulders. Some of the most famous are Capsize Rock, which captures the unwary in Rapid 15, and Niagara Rock in Big Drop Two, which forms a fierce hole during high water. None of the rapids in Cataract Canyon are directly affected by bedrock beneath the river. Instead, water is flowing over a mantle of large boulders.

Most of these boulders were placed in the river by debris flows from side canyons. Like concrete flowing from a cement mixer, debris flows are slurries of sediment and water, with sediment making up more than 80% of the mix. But on this scale, flows have enough energy to move house-sized boulders. Although isolated rock falls affect the river on occasion, debris flows are the most common process for forming and maintaining rapids.

In 1921, the U.S. Geological Survey (USGS) sent a research expedition through Cataract Canyon to locate potential dam sites for water storage and hydroelectric power generation. To evaluate the sites and estimate the volume of water that could be stored in a reservoir, they surveyed the first longitudinal profile of the river. Today we have a complete longitudinal profile of the Colorado River from its headwaters in Colorado to the Gulf of California.



At Spanish Bottom, scientists discovered 260 feet of sediment below the water's surface.

In 2003, a USGS team resurveyed the 1921 Cataract Canyon profile and measured changes in the fall of various rapids. Results from this work show that the profile of the river through Cataract Canyon forms a "bulge" or "convexity" in the overall profile of the river. This bulge is the largest on the river and suggests that bedrock is far beneath the surface.

Using seismic refraction, scientists evaluated the depth to bedrock in several locations. This method involves transmitting sound waves into the ground and measuring the returning waves. At Spanish Bottom, near the head of the Cataract Canyon convexity,

bedrock was found to be 260 feet below the water's surface.

Conventional wisdom holds that rivers constantly erode the land over which they flow. In Cataract Canyon, this doesn't appear to be the case. Due to debris flows from side canyons, the river may be rising. In fact, Cataract Canyon may be one of the most actively filling canyons in the world.

The USGS will continue this work in the coming years. Their results may very well change our understanding of local rivers and the natural processes which guide their evolution.